

Appl. No. 10/667,134
Amdt. Dated June 19, 2006

Attorney Docket No. 89227.0005
Customer No. 26021

Reply to Advisory Action of March 16, 2006 and Office Action of October 20, 2005

REMARKS

This application has been carefully reviewed in light of the Advisory Action dated March 16, 2006 and Office Action dated October 20, 2005. Claims 5 and 18 are amended. Support for the amendment to claim 5 can be found at p. 39, lines 16-21 of the Applicant's specification. New claims 26-32 are added. Support for new claim 26 can be found at p. 39, lines 16-21 of the Applicant's specification. Support for new claims 27-31 can be found at p. 47, line 20-p. 48, line 9 of the Applicant's specification. Claims 3-8 and 11-31 remain in this application. Claims 5, 11, 18, 19, 25, 27-31 are the independent claims. It is believed that no new matter is involved in the amendments or arguments presented herein. Reconsideration and entrance of the amendment in the application are respectfully requested.

Art-Based Rejections

Claims 11-14 and 17-24 were rejected under 35 U.S.C. § 102(b) over U.S. Patent No. 5,081,229 (Akahori); Claims 3-8, 15, 16, and 25 were rejected under 35 U.S.C. § 103(a) over Akahori in view of JP 2000-297163 (Tanaka). Applicants respectfully traverse the rejections and submit that the claims herein are patentable in light of the arguments below.

The Akahori Reference

Akahori is directed to a polyimide resin known as a heat-resistant resin and, more particularly, to a novel copolyimide possessing excellent thermal dimensional stability and mechanical properties. (*See, Akahori, column 1, lines 10-14*).

The Tanaka Reference

Tanaka is directed to obtaining a polyimide film having a high modulus and a specified storage modulus by preparing the same from a polyamic acid prepared by

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reacting p-phenylenebis(trimellitic monoester anhydride) and oxydiphthalic dianhydride with p-phenylenediamine and 4,4'-diaminodiphenyl ether. (See, *Tanaka, ABSTRACT, Problem To Be Solved Section*).

The Claims are Patentable Over the Cited References

The present invention is directed to a polyimide film.

CLAIM 5

As defined by independent Claim 5, a laminate includes a polyimide film. The invention set forth in claim 5, as amended, and each of the independent claims relates to the polyimide film that is produced by using a bis(trimellitic monoester anhydride), represented by General Formula (4), as an acid dianhydride component. The invention also relates to a laminate that is produced by using the polyimide film. Further, the invention set forth in the new claims relates to a polyimide film producing method in which p-phenylene bis(trimellitic monoester anhydride) is used as an acid dianhydride component. The invention also relates to a method in which the $\tan \delta$ peak is controlled to fall in a range of 310°C to 410°C.

The applied references do not disclose or suggest the above features of the present invention as defined by independent claim 5. In particular, the applied references do not disclose or suggest "a dynamic viscoelasticity whose $\tan \delta$ peak is located in a range of not less than 310°C but not more than 410°C, and whose $\tan \delta$ value at 300°C is not more than 0.05," as required by independent claim 5.

Akahori discloses that by modifying a polyimide polymerization method, it is possible to obtain a polyimide film which is excellent in the thermal size stability and the mechanical property, so that the polyimide film is free from any warp or any curl upon being laminated on a metal foil. More specifically, Akahori recites the following arrangement: aromatic dianhydride and diamine including ODA and P-PDA are used, and either aromatic dianhydride or diamine is excessively used so

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as to produce a polyamic prepolymer having an acid dianhydride end and a diamine end, and then the polyamic prepolymer is used as part of the diamine component or the acid dianhydride component, thereby producing a polyimide film having a desired property.

Thus, the invention taught by Akahori is characterized by the kind of diamine used to produce polyimide and in a polyimide polymerization method. Akahori does not disclose producing a polyimide film by using a bis(trimellitic monoester anhydride).

Akahori merely describes modifying the polymerization method of polyimide to obtain a polyimide film that excels in heat dimension stability and mechanical properties, and the reference asserts that the polyimide film does not cause bending or curling when it is laminated on a metal foil. That is, Akahori does not describe anything about using a bis(trimellitic monoester anhydride), nor does it disclose the design of the polyimide described in the present invention. For example, Akahori is totally silent as to the idea of designing the polyimide film as described in the present invention, namely, the reference does not teach that (i) the bis(trimellitic monoester anhydride) is used to control dynamic viscoelasticity of the polyimide film, and (ii) the polyimide film has the $\tan \delta$ peak of dynamic viscoelasticity in a range of 310°C to 410°C, wherein the value of $\tan \delta$ at 300°C is controlled at 0.05 to reduce the thermal shrinkage rate of polyimide film at high temperatures.

Tanaka cannot remedy the above noted deficiencies of Akahori. Tanaka describes using four kinds of monomers to produce a polyimide film of properties (high modulus of tensile elasticity, low coefficient of linear expansion, and high coefficient of hygroscopic expansion) that are required for a flexible printed circuit board or the like. However, Tanaka is totally silent as to the idea of designing the polyimide film as described in the present invention, namely, the reference does not teach that (i) bis(trimellitic monoester anhydride) is used to control dynamic

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viscoelasticity of the polyimide film, and (ii) the polyimide film has the $\tan \delta$ peak of dynamic viscoelasticity in a range of 310°C to 410°C, wherein the value of $\tan \delta$ at 300°C is controlled at 0.05 to reduce the thermal shrinkage rate of polyimide film at high temperatures.

Hence, there is no motivation for combining the Tanaka and Akahori references to obtain the polyimide film that has a low thermal shrinkage rate at high temperatures. Even if these references were combined, it would not be possible to readily realize the present invention, because a person ordinary skill in the art would not have been able to come up with the idea of using a bis(trimellitic monoester anhydride) to control dynamic viscoelasticity of the polyimide film.

Further, Akahori and Tanaka are totally silent as to the idea of designing the polyimide film as described in the present invention, namely, these references do not teach that, in order to meet the two contradictory requirements of the polyimide film that good alkali etching properties are incompatible with long-term stability under harsh conditions (high temperatures and high humidity), pyromellitic dianhydrides are polymerized with biphenyl tetracarboxylic dianhydrides, which are then co-polymerized with a bis(trimellitic monoester anhydride).

Accordingly, independent claim 5 and the other independent claims are believed to be in condition for allowance and such allowance is respectfully requested.

CLAIM 11

As defined by independent claim 11, a polyimide film prepared by copolymerizing an acid dianhydride component and a diamine component, the acid dianhydride component including a pyromellitic dianhydride being represented by General Formula (1) and a biphenyl tetracarboxylic dianhydride being represented by General Formula (5), the polyimide film having such an etching speed that one

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side thereof is etched with a 1N potassium hydroxide solution at an etching speed of 0.1 $\mu\text{m}/\text{minute}$ (one side) or higher.

The applied references do not disclose or suggest the above features of the present invention as defined by independent claim 11. In particular, the applied references do not disclose or suggest "the polyimide film having such an etching speed that one side thereof is etched with a 1N potassium hydroxide solution at an etching speed of 0.1 $\mu\text{m}/\text{minute}$ (one side) or higher," as required by independent claim 11.

Akahori recites a polyimide film prepared by copolymerizing a biphenyl tetracarboxylic acid and a pyromellitic dianhydride. Akahori is totally silent about a polyimide film etched at an alkali etching speed of 0.1 $\mu\text{m} / \text{minute}$ (one side) or higher. Akahori teaches obtaining a polyimide film which is free from any warp or any curl upon being laminated on a metal foil. However, Akahori is totally silent about the alkali etching property.

Further, the polyimide film according to claim 11 of the present invention is such that: unlike a conventional polyimide film whose stability drops under harsh environments upon improving the alkali etching property, a film itself has long-term stability under harsh environments even though the alkali etching speed is high. The Applicants found it possible to realize an excellent alkali etching property by preparing a polyimide film including a bis(trimellitic monoester anhydride) as its copolymerization component for example. Further, the Applicants found that a film having an excellent alkali etching property does not have long-term stability under harsh conditions (high temperature and high humidity). That is, both the alkali etching and the degradation under high temperature and high humidity are caused by the hydrolysis, so that it is extremely difficult to realize both the improvement of the alkali etching property and the higher long-term stability under the harsh conditions (high temperature and high humidity). Thus, a

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film having these contrasting properties has not been found. That is, a polyimide film having (i) a higher etching speed in being etched with an alkali etchant whose alkali concentration is low and (ii) excellent environment-resistant stability has not been found. It is an aspect of the present invention that the Applicants obtained a polyimide film having an excellent alkali etching property. It is a discovery of the present invention that the Applicants found it possible to improve the environment-resistant stability by polymerizing a biphenyl tetracarboxylic dianhydride as a polyimide polymerization component. Further, the Applicants uniquely found it possible to realize both the higher environment-resistant stability and the more excellent alkali etching property, for example, by polymerizing a biphenyl tetracarboxylic dianhydride with a pyromellitic dianhydride and copolymerizing a bis(trimellitic monoester anhydride). As a result of these discoveries, the Applicants succeeded in obtaining a polyimide film having both the higher alkali etching speed and the excellent environment-resistant stability. These findings are neither taught nor suggested in Akahori. Thus, the invention according to claim 11 is neither anticipated or rendered obvious by Akahori.

While Tanaka recites a polyimide film constituted of four components: p-phenylene bis(trimellitic monoester anhydride), oxydiphthalic dianhydride, p-phenylenediamine, and 4,4'-diaminodiphenylether, Tanaka is totally silent about an object of claim 11 which is to improve the alkali etching property of the polyimide film. Thus, there is no motivation for combining Tanaka with Akahori in improving the alkali etching property of the polyimide film. Further, neither Akahori nor Tanaka teach or suggest a combination thereof.

Accordingly, the applied references do not teach or suggest the features of independent claim 11.

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CLAIM 19

As defined by independent claim 19, a polyimide film prepared by copolymerizing an acid dianhydride component and a diamine component. The acid dianhydride component includes the pyromellitic dianhydride, represented by General Formula (1), in a range of from 40 mole% to 80 mole%, the biphenyl tetracarboxylic dianhydride, represented by General Formula (5) in a range of from 1 mole% to 40 mole%, and the bis(trimellitic monoester anhydride, represented by General Formula (4), in a range of from 20 mole% to 50 mole%. The diamine component includes the paraphenylene diamine, represented by General Formula (2), in a range of 25 mole% to 75 mole%, and the diamine diphenyl ether, represented by General Formula (3), in a range of 25 mole% to 75 mole%.

The applied references do not disclose or suggest the above features of the present invention as defined by independent claim 19. In particular, the applied references do not disclose or suggest "the acid dianhydride component including the pyromellitic dianhydride, represented by General Formula (1), in a range of from 40 mole% to 80 mole%, the biphenyl tetracarboxylic dianhydride, represented by General Formula (5) in a range of from 1 mole% to 40 mole%, and the bis(trimellitic monoester anhydride, represented by General Formula (4), in a range of from 20 mole% to 50 mole%, the diamine component including the paraphenylene diamine, represented by General Formula (2), in a range of 25 mole% to 75 mole%, and the diamine diphenyl ether, represented by General Formula (3), in a range of 25 mole% to 75 mole%," as required by independent claim 19.

Akahori discloses an arrangement in which a polyimide film is produced by using (i) a diamine component including a diamino diphenyl ether and a paraphenylene diamine as essential components and (ii) an acid dianhydride component including a pyromellitic dianhydride and a biphenyl tetracarboxylic dianhydride. However, Akahori is totally silent about an arrangement in which a

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paraphenylene bis(trimellitic anhydride) is used. Further, Akahori is totally silent about an arrangement in which a polyimide film is produced by using the foregoing five components (the diamine diphenyl ether, the paraphenylene diamine, the pyromellitic dianhydride, the biphenyl tetracarboxylic dianhydride, and the paraphenylene bis(trimellitic anhydride)) used in producing the polyimide film according to claim 19 of the present invention at a specific rate.

Tanaka discloses a polyimide film that is constituted of four components: p-phenylene bis(trimellitic monoester anhydride), oxydiphthalic dianhydride, p-phenylenediamine, and 4,4'-diaminodiphenylether. Tanaka is totally silent about an arrangement in which a polyimide film is produced by using the foregoing five components (the diamine diphenyl ether, the paraphenylene diamine, the pyromellitic dianhydride, the biphenyl tetracarboxylic dianhydride, and the paraphenylene bis(trimellitic anhydride)) used in producing the polyimide film according to claim 19 of the present invention at a specific rate. Further, in paragraph [0050] of Tanaka states:

A slight amount of a diamine monomer component other than the four monomers is added, that is, 10 mol% or less of whole the diamine or 15 mol% or less of whole the acid dianhydride is added, thereby minutely adjusting a property of the obtained polyimide film. This condition depends on which kind of monomer is used, but it is possible to keep the favorable moisture absorption property, the favorable thermal property, and the favorable mechanical property, as long as the copolymerization is carried out with an amount equal to or less than the foregoing amount. As the slight amount of monomer, ... , examples of the acid anhydride include 3,3', 4,4'-biphenyl tetracarboxylic dianhydride, 3,3', 4,4'-benzophenone tetracarboxylic dianhydride, a pyromellitic dianhydride, 3,3', 4,4'-diphenyl sulfone tetracarboxylic dianhydride, and the like.

This language suggests that it is not so preferable to use a large amount of other monomer component such as the pyromellitic dianhydride. Thus, the

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invention according to claim 19 contradicts the Tanaka invention in terms of the technical concept; and Tanaka teaches away from the present invention. Applicants respectfully submit that a person with ordinary skill in the art who refers to Tanaka would not produce a polyimide film at least by using 40 to 80 mol% of pyromellitic dianhydride in the same manner as in the polyimide film according to claim 19 of the present invention.

Further, neither Akahori nor Tanaka has a teaching or suggestion that: it is possible to obtain a polyimide film wherein not only the initial peel strength is excellent but also the peel strength retention after a harsh environmental resistance test by using a monomer constituted of the five components (the diamine diphenyl ether, the paraphenylene diamine, the pyromellitic dianhydride, the biphenyl tetracarboxylic dianhydride, and the paraphenylene bis(trimellitic anhydride)) at a specific rate. Thus, there is no motivation for combining Tanaka with Akahori in obtaining the polyimide film extremely excellent not only in the initial peel strength but also in the peel strength retention after the harsh environmental resistance test. Further, neither Akahori nor Tanaka teach or suggest a combination thereof.

Accordingly, the applied references do not disclose or suggest the features of independent claim 19.

Independent claims 18 and 25 define a laminate produced by using a polyimide film arranged in the same manner as claims 11 and 19, respectively, and are therefore patentable over the cited references for the same reasons discussed above. The remaining claims depend either directly or indirectly from the independent claims 5, 11, 18, 19, and 25 and recite additional features of the invention which are neither disclosed nor fairly suggested by the applied references and are therefore also believed to be in condition for allowance.

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New claims 26-31 are similarly believed to be in condition for allowance for the reasons discussed above.

Conclusion

In view of the foregoing, it is respectfully submitted that the application is in condition for allowance. Reexamination and reconsideration of the application, in view of the foregoing amendments, are requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles, California telephone number (213) 337-6810 to discuss the steps necessary for placing the application in condition for allowance.

If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,

HOGAN & HARTSON L.L.P.

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By: 

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